3.B.2.b (3) Operating Load Factors.

(a) Tables.

i. Sample Load Analysis (Figure 3-3).

ii. Typical Operating Load Factors (Figure 3-4).

(b) References.

i. U.S. Navy Design Data Sheet, DDS 310-1, "Design Details of Generating Plants."

ii. SNAME T & R Bulletin 3-11, "Marine Steam Power Plant Heat Balance Practices," Section 3.2.15.

iii. Marine Engineering, Harrington, 1971, pp. 607-609.

iv. NVIC 8-84, section 28.d.(1) (see paragraph 3.L.2 below).

(c) General Requirements. Ship's service generating plants must be sized for the anticipated operating load as required by 46 CFR 111.10-4. Emergency generators shall be sized to supply all loads simultaneously connected to it as required by 46 CFR 112.05-5. To determine if the generators are adequate, a load analysis is necessary and is required to be submitted for review by 46 CFR 110.25-1(b). Demand factors (d.f.) are essential to the load analysis but often can vary, as can be seen from the typical values in Figure 3-4. The individual characteristics of the vessel should be considered in the determination of demand factors. The review of the load analysis should determine if the:

i. Individual load factors used are reasonable.

ii. Application of the load factors is reasonable and thorough.

iii. Generating plant is adequate and in accordance with the applicable regulations.

(d) Considerations.

i. Loads can be classified by various operating conditions such as port, anchor, sea, functional, emergency, maneuvering, or cold start. For the purpose of plan review, only the normal sea load, maneuvering load and emergency load are considered, unless special considerations for the safety of the ship require otherwise (e.g., at sea cargo transfer (functional)).

ii. A motor may be oversized for its attached load and thus not operate at its rated capacity.

FIGURE 3-3
SAMPLE LOAD ANALYSIS

NOTE: All figures used are purely hypothetical.

DISTRIBUTION A	ATTACHED LOAD	DEMAND FACTOR	DEMAD LOAD
Bilge Pump	5 KW	0	0
Ballast Pump	10 KW	0.1	1 KW
A/C - Heater	10/20 KW	0.8	8/16 KW*
Cargo Circ. Pump	15 KW	0.6	9 KW
	Dist. A Total 0 + 1 + 16 + 9	=	26 KW
DISTRIBUTION B			
Steering Pump #1	10 KW	0.9	9 KW
Steering Pump #2	10 KW	0	0 **
Steering Control	1 KW	0.9	.9 KW
Bow Thruster	40 KW	0.4	16 KW
	Dist. B Total 9 + 0 + .9 + 1	=	25.9 KW
DISTRIBUTION C			
Main Deck Ltg. Fwd.	4 KW	0.5 ***	4 KW
Main Deck Ltg. Aft	4 KW	0.5	
Eng. Rm. Ltg. Port	2 KW	0.9 ***	3.6 KW
Eng. Rm. Ltg. Stbd.	2 KW	0.9	
	Dist. C Total 4 + 3.6 =		7.6 KW
DISTRIBUTION D			
Range	12 KW	0.4	4.8 KW
Water Heater	15 KW	0.6	9.0 KW
	Dist. D Total	4.8 + 9.0 =	13.8 KW
TRANSFORMER #1			
Dist. C	7.6 KW		1.0 @ .95
Dist. D	13.8 KW		Efficiency ****
Transformer 1 Total is 1.05 (1.0)(7.6 + 13.8)			= 26.9 KW
MAIN SWBD			
Dist. A			26 KW
Dist. B			25.9 KW
Transformer #1			26.9 KW
Generator Demand load			78.8 KW
Full load Gen. Capacity			85 KW

* Relationship exists, take larger load.
** One pump is the standby.
*** Similar loads given group factor.
*** Reduced efficiency increases demand load. typ. transformer eff .96-.99

FIGURE 3-4

TYPICAL OPERATING LOAD FACTORS

LOAD DESCRIPTION	NAVY FACTORS		MAR. ENG. FACTORS		SNAME
	Sea	Emerg	Sea	Emerg	Sea
Main Steering Gear Pump	0.3	0.3	0.1		0.2
Stby. Steering gear pump	0	0			
Steering gear servo. Pump	0.5	0.5			
Steering control	0.5	0.5	0.1		
Steering aux. Heater	0	0			
Shaft turning gear	0	0			
Stern tube bearing lube oil pump			0.5		
Main cond. Pump	0.9	0	0.4		0.75
Main circ. Pump	0.9	0	1.0		0.9
Aux. cond. Pump					0.9
Aux. circ. pump	0.6	0			0.9
Main feed pump					0.8
Main feed boost pump	0.9	0.5			
Emer. feed boost & transfer pump	0	0			0
Reserve feed transfer pump	0.2	0			0.5
Aux. condenser condensate pump			0		
Atm. Clean drain tank pump			0.6		
L.P. heater drain pump					0.65
L.P. steam gen. Feed pump			0.9		
Aux. boiler	0	0			
Main turb. gland exhauster	0.9	0	0.9		0.9
Aux. turb. gland exhauster	0.5	0			
F.W. Drain coll. Tank pump	0.6	0			0.6
Main L.O. purifier	0.3	0	0.9		0.35
Main feed L.O. pump	0.9	0	0.9	0.3	0.9
Stby. L.O. serv. pump	0	0.2		1.0	
L.O. transfer pump	0.1	0			0
L.O. cooler circ. pump					0.9
L.O. heater					0.1
F.O. service pump	0.9	0	0.4		0.85
F.O. transfer pump	0.1	0	0.1		0.1
F.O. stripping pump	0	0			
F.O. stripping drain and transfer pump	0.3	0			
Red. gear L.O. stby. pump	0	0			
Prop. hyd. stby. pump	0	0			
Elec. prop. exciter	0.9	0			
Elec. prop. equip. heater	0	0			
Prop. motor vent fan	0.9	0			
Prop. motor L.O. service pump	0.9	0			
T/G circ. pump	0.5	0			

FIGURE 3-4 (Continued)

LOAD DESCRIPTION	NAVY FACTORS		MAR. ENG. FACTORS		SNAME
	Sea	Emerg	Sea	Emerg	Sea
T/G cond. Pump	0.5	0			
T/G start L.O. pump	0	0.9		0.9	
Sea valves	0	0			
Emer. gen. S.W. booster	0	0.9			
S.W. boost pump	0.3	0			
Air preheater					0.9
S.W. service pump	0.1	0	0.6		0.8
Bilge and fuel stripping pump	0.1	0	0.1		
Bilge pump	0.1	0	0.1		0.1
Flushing pump	0.1	0			0.4
Fire pump	0.2	0.4	0		0
Bilge & ballast priming pump		0	0.1		
Fire and bilge pump					0
Fire and general service pump			0		
Bilge and ballast pump					0.2
Ballast pump					0.2
Fog/Foam sys. Pump	0		0		
Forced draft blower			0.5		
H.W. circ. Pump	0.6	0	0.1		0.7
H.W. heater	0.5	0.1			0.5
Cargo stripping pump	0	0			
Liquid Cargo transfer pump	0	0	0		0
Cargo brine circ. pump			0.7		
Cargo air coolers			0.9		
Cargo dehumidifier					0.5
Window defrosters and wipers	0	0			
Generator space heaters	0	0		1.0	
Anchor windlass	0	0			
Capstan	0	0			
Personnel elevators	0.2	0			
Cranes	0	0			
Cargo elevators	0	0			
Shop tools	0.1	0	0.1		0.1
Welder	0.1	0			
Test board	0.1	0	0	0	0.2
Battery charger	0.2	0			0.2
I.C. battery charger				1.0	
Ventilation	0.9	0.4	0.9		0.85
Duct & space heaters	0.4	0			0.4
Deck mach. Heaters					1.0
I.C. system	0.4	0.4		1.0	0.4
Radar	0.5	0.5		1.0	
Gyro				0.5	0.4

FIGURE 3-4 (Continued)

LOAD DESCRIPTION	NAVY FACTORS		MAR. ENG. FACTORS		SNAME
	Sea	Emerg	Sea	Emerg	Sea
Radio	0.4	0.4			
Searchlights	0	0			
Mach. space ltg.	0.9	0.9			0.9
General ltg.	0.6	0.4	0.4		0.6
Emergency ltg.	0.6	0.4		0.9	
Navigation ltg.	0.6	0.2		0.4	0.5
Service area ltg			0.4		0.35
SS. reefer circ. pump					0.4
SS. reefer compressor	0.3	0	0.1		0.4
Cargo reefer cmp.	0.3	0	0.6		
A.C. compressor	0.7	0.4	0.8		0.75
A.C. chill wtr. pump	0.7	0.4	0.9		0.75
A.C. S.W. circ. pump	0.7	0.4			0.75
A.C. fan					0.75
A.C. H.W. circ. pump			0.6		0.75
Unit coolers	0.2	0			
Oven/range	0.4	0			
Galley equip.	0.3	0			0.3
Refrig/freezer	0.5	0			
Refrig. small	0.3				0.3
Pantry equip.	0.2	0			0.3
Laundry equip.	0.2	0			0.2
Hospital equip.	0.1	0.1			0.2
Electronics	0.5	0.2	0.5		0.45
Distiller plant	0.7	0			
Distiller brine ovbd.			0.8		0.75
Distiller cond. pump			0.3		0.6
Distiller feed pump			0.8		0.75
F.W. transfer pump			0		
Ice water circ. pump			1.0		0.7
Potable water pump	0.3		0.2		
Drinking fountain	0.4				
H.P. air compressor	0.1				
S.S. air compressor	0.1		0.1		0.3
Control air compressor	0.6		0.2		0.4
Sewage pump	0.1		1.0		0.2
Sewage macerator	0.1		1.0		
Sewage blower			1.0		
Cathodic protection			0.7		
Ice water circ. pump			1.0		0.7
Brine circ. pump			1.0		
Reefer container recept.			0.9		
Winches					
Bow thruster					
Main control console			0.6		
Boiler console			0.6		
R.A.I., E.O.T., alarms			1.0		

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iii. Reference (ii) provides formulas for the determination of load factors for major steam propulsion vessels.

iv. Load factors for individual loads, in general:

$$\text{Load factor} = \frac{\text{Operating bhp}}{\text{Rated bhp}} \times \frac{\text{No. hours operation}}{\text{24 hours}}$$

or

$$\text{Load factor} = \frac{\text{Operating KW}}{\text{Rated KW}} \times \frac{\text{No. hours operation}}{\text{24 hours}}$$

Often, operating load information is not provided and load factors become $\frac{\text{No. hours operation}}{\text{24 hours}}$

v. A single load factor for group loads may be assigned if they meet one of the following criteria.

a. Two or more loads operate with a definite relationship to each other (e.g., heating and air conditioning);

b. When the relationship described in (a) above is not clear, but is known to exist (e.g., galley equipment);

c. When low power loads in the same space can be assigned roughly the same load factors (e.g., radios and electronics).

vi. Known load use data should always be used in lieu of demand factors, if available.

vii. Power conversions and their efficiency should be considered (e.g. power factors, transformers, semiconductor controlled rectifiers (SCR's). Due to efficiency below 1.0, apparent connected loads may be increased due to the conversion equipment).

viii. Loads that are provided individual factors in the analysis should not be additionally assigned a group factor, and vice versa (e.g., 0.3 (individual factor) x 0.4 (group factor) =0.12 (final factor) (either 0.3 or 0.4 could be used, but not 0.12)).

ix. Factors of zero (0) are assigned to equipment that is seldom used.

x. Factors of 0.9 and 1.0 are used where motors operate at full load for an extended period of time.

xi. Standby units, or duplicate units, should be listed and assigned a factor of zero unless it is continuously idling. The primary unit should be assigned an

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xi. (cont'd) appropriate factor, e.g., Steering pump No. 1, d.f. 0.9; Steering pump No. 2, d.f. = 0.0 (Stby).

xii. The development of standard load factors for given classes of vessels is encouraged, as time and experience permit.

xiii. Large equipment-unusually large loads, as compared to the generating capacity-should be assigned appropriate factors assuming that other non-essential loads are not operated simultaneously.

xiv. As a final check on the adequacy of a load analysis, check to see that the generating plant is adequate to simultaneously carry the loads vital to the survival of the vessel in an emergency such as fire or flooding. These loads should include:

a. Steering;

b. Vital propulsion auxiliaries;

c. Ventilation;

d. Communications;

e. Fire pumps;

f. Alarms;

g. Bilge pumps;

h. Emergency lighting;

i. Radar; and

j. Controls.

xv. For unmanned machinery spaces, remotely operated emergency loads, such as bridge started fire pump, should be assigned a load factor of 1.0.

xvi. Automatically started equipment should be provided a load factor of 1.0 without regard for spinning reserve.

xvii. Special functional operations of the vessel, such as underway replenishment (a Military Sealift Command (MSC) ship), dredging (a hopper dredge), and at-rig offloading (an offshore supply vessel) do not require one generator in reserve. Normal at sea operations such as cargo cooling (refrig. ship) and liquid cargo recirculation (offshore supply vessels) do require one generator in reserve.